AN ADDRESS

DELIVERED BEFORE THE

MASSACHUSETTS COLLEGE OF PHARMACY,

AT THE

NINTH ANNUAL COMMENCEMENT,

ON

The Relations of Chemistry to Pharmacy and Therapeutics.

BY T. STERRY HUNT, LL. D., F. R. S.

WITH THE

VALEDICTORY TO THE GRADUATING CLASS OF 1875.

BY PROF. WILLIAM P. BOLLES, M. D.

BOSTON, MAY 20, 1875.

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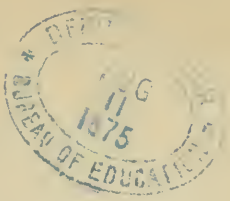

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THE RELATIONS

OF

CHEMISTRY TO PHARMACY AND THERAPEUTICS.

By T. Sterry Hunt, LL. D., F. R. S.

When I was invited to undertake the honorable task of giving the address on this occasion — the close of the ninth year of the Massachusetts College of Pharmacy — I could at first only plead my unfitness on the ground that I am neither a pharmacist nor a physician ; but on reflection, I considered that chemistry and chemical physiology, studies to which I have given some attention, sustain such relations to pharmacy as might perhaps justify me in attempting to address you this evening. Looking back to my early days, when I learned the rudiments of practical chemistry in the laboratory of an apothecary, I am enabled, with surprise and delight, to understand the great advances which have been made in your art within the past twenty-five years, the progress of which in this country has been due to the labors of this and other similar schools of pharmacy, and to the admirable work of the American Pharmaceutical Association, which proposes to hold its twenty-third annual meeting here in September next. Both in making known the results of foreign research, and in forming skilled students at home, the work of the Association and of the various pharmaceutical schools here and in New York, Philadelphia, Baltimore, Chicago, and others of our principal cities, has been a great and a beneficent one ; and already the labors of American investigators are taking a highly important place in the annals of your science.

In looking over the history of pharmacology, and considering it in its relations with the therapeutic or healing art on the one hand, and with chemistry on the other, we see how difficult it is to draw the lines of separation between them, or rather how closely both of

the former are dependent upon chemistry and chemical physiology. In the remote past, it is true, the physician knew but little of these sciences, the growth of a later age; but how limited were then his powers and his resources! His materia medica included a few drugs and simples of real power, the virtues of which had been found out by happy accident, but consisted to a great extent of substances selected in accordance with strange and superstitious notions, and very often as destitute of real medicinal virtues as the ingredients of the witch's caldron in "Macbeth," in describing which one is tempted to suppose that the great poet, who displays such a wonderful familiarity with the medical science of the day, meant to satirize the ancient pharmacy, not yet obsolete in his time.

The advances made in the science of medicine within the last century are due in great part to the discoveries of chemistry; or rather let us do justice to the labors of the early pharmaceutists and say that to these, more than to any other class of students, we owe modern chemistry. Our chemical science had its humble beginnings in the shops of the dyer, the metal-worker, the potter, the glass-maker, but above all in the laboratory of the apothecary.

To allay pain, to heal sickness, to avert disease, and to prolong life were problems that from the earliest ages engaged the attention of mankind; and the conviction that Nature held in her treasure-house agents that were potent to these ends inspired the early physician, and the alchemist "raking the cinders of his crucible for life and power." At first, it is true that their efforts were chiefly limited to the extraction of remedies from the organic world, the products of which seemed more congenial to the human frame than those of the mineral kingdom, and in their choice of these they were often guided by the fanciful doctrine of signatures. We early find, however, that occult and mysterious virtues were ascribed to various minerals, and especially to gems, and here the doctrines of astrology came in. The metals, not less than men, were supposed to be subject to the influences of the planets; and iron and copper, lead and silver, sacred to Mars and Venus, to Saturn and to Luna, might well be supposed to share somewhat of the virtues of the celestial bodies whose names they bore, and thus, apparently, they found their way into medicine.

To the alchemist the draught which was to bestow on favored man the gift of perpetual youth was no longer, as poets had fabled, a fountain springing in some far-off, enchanted land: the potent liquor was to be distilled in his own laboratory; and it was in the

pursuit of this elixir of life, and in the kindred phantom of the philosopher's stone, which was to transmute the baser metals into gold, that the discoveries were made which have been the foundation of modern chemistry.

Tradition traces the origin of this science to Egypt ; but the considerable chemical knowledge which, as their monuments attest, was possessed by this ancient people, perished with their greatness, and it was in that wonderful awakening of the Arab mind which followed the advent of Mahomet that we find the dawn of a new era in the science of chemistry. Geber and the great physicians of Arabia then applied themselves with wonderful success to the chemical investigation of their materia medica, and devised many of our modern modes of investigation. To this school we owe our knowledge of distillation, a process which at once enlarged immensely the resources of chemists, both by enabling them to extract the volatile active principles of things, and by putting them in possession of precious agents for further research, such as alcohol, which they first made known. The very names which they impressed upon the science, and which remain to this day familiar words in our language, bear witness to the great influence of these early Arab physicians and pharmacists. Their teachings found their way into Europe, and in the ninth century we find the School of Salernum already celebrated for medicine and pharmacy. The knowledge of the Arabian chemists was carried by victorious Moors into Spain ; and returning crusaders, who gathered some learning from their more enlightened foes, brought back to Europe that science which was destined soon to perish utterly from the land of its birth, but to be preserved as a precious heritage in western Europe.

Throughout the Middle Ages it is often difficult to separate alchemy from pharmacy, — the search for the art of making gold from that for the elixir of life. Both were attempted by the crucible and the alembic, and the two pursuits were deemed kindred, and often united in the same persons, who, if they were unsuccessful in their professed aims, added continually to our knowledge of chemistry, while each new spirit, sublimate, or salt was essayed upon the human frame. Basil Valentine, Paracelsus, Van Helmont, and others, despite their visionary alchemistic speculations and their astrological fancies, made precious additions to the materia medica, and deserve a high and an honorable place in the history alike of medicine, pharmacy, and chemistry. To one of these we owe the discovery of antimony, to another the medicinal use of mercury, and to the third

preparations of opium which long held their place in medical practice. With the eighteenth century is connected the birth of modern chemistry, whose centennial was last year celebrated; and while Priestley and Lavoisier are honored as having given a new impulsion to chemical theory, the name of the Swedish apothecary, Scheele, will always be remembered as one who probably enriched the science with more discoveries than either of them, and, perhaps, contributed more to the progress of practical chemistry.

But if pharmacy in former ages had been the nursing-mother of chemistry, its help was not to be dispensed with when her child, the heir of all the traditions of the past, bearing the secrets which had been found out by centuries of toil in the laboratory, and equipped with a new philosophy and a new nomenclature, entered upon its new career. The three brightest names on its roll in our century have been gathered from the ranks of the pharmaceutical profession. Sir Humphrey Davy, whose wonderful chemical discoveries made him famous in the early part of this century, was trained as an apothecary in an obscure town in Cornwall, in England, until, his skill in chemistry having become known, he was invited to assist by his knowledge in the direction of an institution at Bristol, where it was proposed to apply the discoveries of Priestley and Lavoisier to the treatment of disease by the inhalation of gases and vapors. To his early experiments in that direction, and to his discovery of the physiological effects of nitrous oxide, we shall again refer.. These were followed by his promotion to the chair of chemistry in the Royal Institution, from which time his name becomes one of the glories of science and of his country.

A quarter of a century later we find two young apothecaries, the one at Darmstadt, in Germany, the other, though a native of Provence, at Geneva, in Switzerland. Their chemical studies in connection with their profession inspired them with desires to devote themselves to pure chemistry, and they met as fellow-students in the laboratory of Thenard, in Paris. The subsequent career of these two, henceforth inseparable friends, is written imperishably on the pages of the history of chemistry. The one died in 1873, and the whole world lamented Justus von Liebig. In his life of seventy years he had done more to diffuse a knowledge of chemistry and of its practical applications than any one else who had ever lived. Not only in the mineral kingdom, but in the domains of animal and vegetable chemistry and physiology his impress is everywhere seen. He may almost be said to have founded the school of modern

organic chemistry by his own remarkable discoveries and by the marvellous impulse which he gave to the hosts of students who, during a period of thirty years, gathered around him, and who learned to love and to reverence the name of Liebig.

His early colleague still survives, full of years and honors, and has for more than a generation been the recognized chief of French chemists. It is only necessary to mention Dumas, the illustrious perpetual secretary of the French Academy of Sciences; for his name, though less familiar to the public than that of Liebig, is inseparably connected alike with the theory of his favorite science and with its most important practical applications. The future historian of the chemical philosophy of this century will, we can scarcely doubt, assign the place of pre-eminence to Dumas.

But I have hitherto given but one side of the case. Putting myself in the position of the pharmaceutist, I have shown what his schools and those trained for it have done for the science of chemistry. Assuming now the chemist's standpoint, I am bound to declare that my favorite science has more than repaid the debt which she owed to pharmacy for its fostering care during the long centuries of her incubation, and for the great men which it has since given her. Nay, more than this, I will maintain that in no other way could Davy, Liebig, and Dumas have so well served both the arts of healing and of pharmacy as by devoting themselves unreservedly to the study and the teaching of theoretical and practical chemistry. The results of the labors of these and of their great predecessors have transformed the pharmaceutical art; they have replaced the crude empiricism of the earlier times by truly scientific methods, based upon sound theory, and have enriched the materia medica with a vast number of new substances, have devised novel and admirable processes, and, more than that, by their contributions to animal physiology have given us rational explanations of the action of a great number of medicines, and have defined principles which will serve as guides to still further and greater discoveries in the healing art.

We have only to look back to the pharmacopœias of one hundred, nay, of fifty years ago, to be satisfied of the wonderful advance which has been made in the resources and appliances of pharmacy. Thanks to the high scientific training of the masters of pharmacy at the present day, there are always found waiting men who are ready to take up every new discovery of the chemist which promises to be of advantage to their art, to consider its bearings and applications,

and to bring out its true value ; so that in no field of applied science are the discoveries of modern chemistry more quickly and more fully utilized than in the preparation of medicines and in the treatment of disease. To illustrate this proposition fully would require a volume ; but for the present occasion I shall avail myself of some few examples, which may serve to show, not only to professed pharmacists and physicians but to their clients and their patients, the services which chemistry has rendered.

Modern chemistry began its work for pharmacy by applying new methods of proximate analysis to the already known remedial agents. The old pharmacopœias were encumbered with numerous crude products of the vegetable and animal worlds, to which medicinal virtues were attributed. Some of these drugs, like coral and the shells of eggs, of oysters, and of crabs, were soon shown by the chemist to have no other value than belongs to the calcareous salts of which they are chiefly composed. The same thing was made known with regard to the horns of the deer, while the volatile salt extracted from them by distillation was found to be identical with that which is abundantly obtained from other and much cheaper sources. These, and numerous other animal products, were henceforth excluded from the materia medica.

On the other hand, positive results of great importance sometimes followed this mode of investigation. Thus, for example, sponge, which, when calcined, had been found to possess a special therapeutic action, was shown to contain a portion of the new and rare element, iodine, which had first been detected by a chemist in the ashes of sea-weed. This was soon discovered to be the active principle of the sponge, and henceforth took its place as one of the most precious substances of the materia medica. The skill of the chemist now concentrates from other and more abundant sources this wonderful curative agent, combines it in saline or in ethereal forms, and enables the physician to avail himself of the virtues of iodine without compelling the patient to ingest the crude and bulky residue from the burning of sponge.

Not less striking than this are the numerous similar examples which are furnished by the vegetable kingdom. The active principles of cinchona, of nux vomica, and of a great number of the most precious drugs, are present in very small portions only in the bark, the leaves, or the fruit of the plants, being diluted, as it were, with a great amount of matter useless in the teratment of disease, and in many cases even irritating and noxious to the palate and to the

stomach. The fevered patient who wished to avail himself of the curative effects of Peruvian bark would be obliged to swallow daily an ounce or more of this material. Here the old pharmacy came in, and by the aid of solvents made decoctions or tinctures or extracts, which gave in a more concentrated and potable form, it is true, the virtues of the bark, but still mingled with a large proportion of foreign and disagreeable elements. It was reserved for modern chemistry to show that the active principle of the cinchona, like that of the burnt sponge, was a distinct and definite substance, and henceforth the curative virtue of an ounce of the bark was represented by a few grains of crystalline and colorless quinine, an alkaline base combining with acids to form soluble combinations, in some of which its medicinal powers are modified and exalted. By the aid of these the physician is now enabled to avail himself of the specific powers of this curative agent in various ways which were before impossible.

Encouraged by this important result, chemistry has shown that very many other vegetable drugs owe their powers to similar alkaline principles or alkaloids, and by the extraction of these has rendered vast services to medicine. The virtues of the plant may be affected by soil, climate, season, or mode of preparation ; but these differences are due to variations in the proportion of the characteristic alkaloid, and with this, when isolated and pure, constant and uniform results are assured. Opium, that precious though much-abused drug, has yielded to the chemist remarkable results. Nature has blended in the juices of the poppy very unlike elements, and these, as they assert in turn their powers, give rise to some degree of irregularity in the physiological action of opium. The chemist's art has, however, shown that this complex extract contains several alkaloids, differing alike in their effects on the animal economy and in their chemical properties, so that they may be isolated from each other and used independently in the treatment of disease. In this way we separate from the others the sedative principle of opium, and administer it in a concentrated form, deprived of its disagreeable taste and smell. More than this, a precious mode of treatment which has resulted from the discovery of the alkaloids, is, that many of these active principles in saline combination and in aqueous solutions may be injected beneath the skin, and thus made to yield the happiest effects in certain cases of disease.

The discovery of the alkaloids constitutes, however, but one of the many important results which have been attained by the proximate analysis of vegetable substances. From many other drugs neutral

crystalline or resinoid matters are separated, which present in a not less concentrated form their active principles ; in other instances their virtues reside in a volatile acid or a neutral volatile oil ; and in each case the skill of the pharmaceutical chemist enables him to separate these from the *caput mortuum*, and give us the medicinal powers of the plant in a form as concentrated as in the alkaloids of cinchona or of opium.

In many cases where the medicinal virtues are not apparently lodged in a single principle capable of being isolated, pharmacy has resource to other processes, and obtains by expression, percolation, and evaporation or distillation, often *in vacuo*, concentrated extracts which enable us to dispense with the crude drugs. While the solvents or *menstrua* of the old pharmacy were confined almost exclusively to water, wine, vinegar, and alcohol, modern chemistry has greatly added to these. Ether, chloroform, sulphide of carbon, the volatile hydro-carbons like benzole, and the so-called petroleum spirits have now each their use, and enable the pharmacist to effect concentrations and proximate analyses which a few years since would have been deemed impossible. Thus, for a single example, by means of the sulphide of carbon the subtile perfumes of the violet and the jasmine, which elude the ordinary processes of distillation, have been isolated. Nor should be forgotten in this connection the extraordinary properties and uses of glycerine, the sweet principle extracted from oils, which now finds a hundred applications in pharmacy and in medicine as a solvent and a vehicle for various remedies, both internal and external — a liquid sugar, neither evaporating nor consolidating, and a precious adjunct to the materia medica.

Few subjects have within the past thirty years more occupied the attention of chemists than the transformation of the bodies of the carbon series, the so-called organic compounds. Possessed with the notion that the generation of these was the prerogative of life, they were at first content to follow the changes which the sugars, oils, resins, alkaloids, acids, and other proximate principles of plants and animals undergo by the influence of heat and various chemical reagents, discovering thereby new and unexpected combinations, until it was at length found that the chemist was enabled thereby to obtain products identical with those which nature produces in the animal and vegetable organisms. The artificial formation of urea, followed by that of valerianic aud benzoic acids, and many other similar cases, opened up a new field for chemistry and for pharmacy. Still another step was soon made : no longer dependent on the

proximate principles of plants as his point of departure, the chemist found it possible to make carbon, or its combinations with oxygen or with sulphur, unite with hydrogen or with water, and thus to build up, like the plants themselves, directly from the mineral kingdom, certain hydro-carbonaceous bodies hitherto supposed to be generated only in the mysterious laboratory of life. From these we rise to higher and higher forms, so that to-day it may be said that there is no known chemical compound of the organic world which it is not possible to generate in our laboratories from mineral matter. The wonderful impetus which discoveries such as these have given to organic chemistry is visible on every side. Many long and laborious researches, devoted not directly to the imitation of the processes of nature, but rather to the object of finding out, if possible, the secret laws in obedience to which she builds up her marvellous combinations, have been undertaken, and with what fruitful results the discoveries of the last few years tell us. By a careful dissection, as it were, of certain organic principles we have learned to reconstruct them ; and the triumphs of this method are seen in the artificial production of indigo, orcine, and alizarine, the coloring principle of madder, which latter is now produced from one of the waste products of coal-tar with more advantage than from the plant itself. One of the latest and most elegant additions to the list of these discoveries is that of the artificial production of the odorant principle of vanilla, by which we are henceforth made independent of tropical climes, and can produce this delicate flavor from the transformation of a substance contained in the bark of our northern pine trees.

What wonder, then, that the chemist should now aspire by the marvellous resources of his synthesis to produce artificially the active principles of the poppy and cinchona, and render cheaper and more accessible those precious drugs, morphine and quinine? We may feel sure that these and similar problems are within the possibilities of modern chemistry, and are destined to be solved at no distant day. If we have hitherto reproduced few of the proximate principles of plants, it should be said that the vegetable kingdom has as yet yielded but a very small proportion of the organic compounds already known to chemistry. If our laboratories have as yet produced but a small proportion of the immense number of possible combinations which our science can foresee, it is not less true that large numbers of alkaloids, acids, and other compounds analogous to those found in plants have already been produced, many of which

have found important uses. Of these, in the domain of pharmacy, we may mention carbolic acid, nitropicric acid, chloral, ether, and chloroform as examples of bodies thus discovered which have proved precious in the hand of the physician and the surgeon.

It is curious, in connection with the anæsthetic agents just mentioned, to recall some points in their history,* the first page of which was written by the chemist Davy, to whom we owe the discovery of the physiological action of nitrous oxide. In his experiments on the inhalation of this gas he had noticed its power to allay severe pain from a tooth, and said, "It may probably be used with advantage during surgical operations in which no great effusion of blood takes place." It is the fault of the surgeons of his time that they did not follow up this suggestion, which was only put in practice by an American dentist in 1844. This application of the inhalation of nitrous oxide for minor surgical operations was followed some two years afterwards by the introduction of ether for the same purpose, and later by that of chloroform. The admirable labors of Dr. Benjamin W. Richardson of London, who for many years has carried on a series of investigations on the physiological action of the vapors of various hydro-carbons, their chlorinized and other derivatives, have greatly enlarged our resources in the production of anæsthesia, and have made known other precious therapeutical agents of which medical science will not be slow to avail itself. In marsh-gas and in its homologue, the hydride of amyl, a very volatile product of the rectification of Pennsylvania petroleum, we have two valuable agents for producing general anæsthesia, and the latter is especially useful for producing local insensibility; while the nitrites of methyl and amyl, though not anæsthetics, possess, according to Dr. Richardson, a specific power in relieving muscular spasm, and from some trials promise to give the means of controlling that dreadful disease tetanus, and combating the poisonous effects of strychnine, while they have been tried with success in *angina pectoris*, and in averting epileptic attacks.

The further history of chloroform presents another curious page. Discovered independently in 1831 by Liebig in Germany, and by Guthrie of Sackett's Harbor, New York, it was the following year employed internally in medical practice as a sedative and antispas-

* For many facts in this connection I am indebted to Professor B. Silliman's valuable lecture on "A Century of Medicine and Chemistry," delivered before the Yale Medical School, New Haven, 1871.

modic by the late Dr. Ives, of New Haven, at the suggestion of Professor Silliman. A little later Liebig discovered chloral, a product of the action of chlorine on alcohol, which, by the action of alkalies, was found to be readily broken up into chloroform and a formiate. Might it not, then, when taken into the stomach, be thus decomposed, and in this manner, by gradually liberating chloroform in the circulation, enable us to obtain effects similar to those produced by the inhalation of the latter? Following out this conjecture Liebreich gave us in 1869 that new and precious sedative and hypnotic, the hydrate of chloral, the power of which to relieve pain and produce sleep makes it an agent not less precious than opium itself. It is worthy of note that this new discovery was the result of an induction from the chemical reactions of chloral as observed in the laboratory, coupled with a knowledge of the chemical agencies at work in the animal circulation.

This latter consideration introduces us to a new field of investigation with regard to the influence of drugs, — namely, the chemical changes which they may undergo in the animal economy, and the relations of these to their physiological action. To take a familiar example: Alkalies, which are not only indispensable to the healthy organism but potent agents in the treatment of disease, are found in our food in combination with organic acids, such as malic, tartaric, citric, and lactic acids. These, like sugar, gum, and fat, are oxidized in the circulation, liberating their combined alkalies in the form of carbonates. Hence the ingestion of the alkaline salts of these organic acids furnishes an indirect way of introducing alkaline carbonates into the circulation, while avoiding the disturbing effects which the direct administration of these has upon the stomach, and thereby modifying the character of certain excretions, — a fact of great importance in the treatment of some forms of diseased action.

But this mode of combining therapeutic agents with organic substances capable, as it were, of being assimilated in the organism, has still wider applications. The mineral salts of many of the metals, such as sulphates and chlorides, act, to a great extent, like foreign substances when taken into the stomach, forming insoluble compounds with albuminous matters; but when combined with those organic acids which are, as it were, nature's vehicles for the introduction of mineral matters (as seen in the juices of fruits and vegetables, and the flesh-fluid), these metals are in a condition well fitted for absorption. Thus it is that the citrates, tartrates, and lactates of bismuth, antimony, iron, zinc, and other metals are

now employed with great advantage to replace the older preparations of these metals in medical practice.

The researches of modern chemistry have, moreover, shown us many remarkable combinations in which metals and other elements of great therapeutic value are combined in a still more intimate manner with the organic elements than in the salts just mentioned. Such are the compounds of antimony, arsenic, mercury, and zinc, of bromine and of iodine, with the alcohol radicles or their derivatives. In many of these the physiological action of these elements is completely masked, as in cacodylic acid, an arsenical derivative of methyl; while the closely related alcarsine exhibits in an exalted degree the physiological effects of arsenical compounds, and has been employed as a therapeutical agent. Still more recently a mercuric compound of ethyl has been introduced into the materia medica as an active form of mercury, possessing many advantages over the ordinary preparations of that metal.

The related compounds of iodine present some remarkable illustrations of the principle just indicated. In iodoform, this element, to the extent of ninety-six per cent, occurs, so combined with carbon and hydrogen that its peculiar physical characteristics are wholly concealed in the form of a fragrant, aromatic, yellow, crystalline solid. It is now nearly thirty years since, having made this singular compound the object of study and experiment, I in vain suggested its medical use to a late distinguished professor in one of our schools of medicine. To-day, however, this substance has taken its place in the materia medica as a valuable preparation of iodine. The compounds of iodine, with the alcohol radicles, have also been introduced into medical practice with the promise of precious results unobtainable by the saline preparations of this element. The iodides of methyl and butyl in solution, administered internally or by way of sub-cutaneous injection, not only exert a remarkable sedative power, but by their specific action upon the glandular system, which they share with other compounds of iodine, have been shown to possess a great value in cancerous affections. It is probable that these organic compounds may be decomposed in the organism, thus liberating in active forms the iodine which they contain.

The process by which organic bodies like the vegetable acids are converted into water and carbonic acid is but a part of that oxidizing action which goes on in the animal circulation by the aid of the inhaled oxygen, which plays such an essential part in the metamorphosis of tissue, — the so-called destructive assimilation. In

oxidizing processes out of the body many substances may act as condensers and carriers of oxygen. Such is the case of iron rust, which is well known to greatly accelerate the otherwise slow decay of vegetable fibre in moist air. In like manner the nitric oxide gas in the leaden chamber in the manufacture of sulphuric acid intervenes between the oxygen of the air and the sulphurous gas, so that the latter, which would else be very slowly oxidized, is rapidly converted into oil of vitriol. It has been suggested that the agency of certain medicaments in the animal economy may be explained in a similar manner; that, for example, the salts of mercury and the compounds of iodine may serve as such intermediaries, and that their power, under certain conditions, of promoting the transformations of organic matters may explain the resolvent and alterative properties which have been ascribed to them. This suggestion, first made, I think, by Odling, acquires an additional significance from the recent observations of Sonstadt on the iodate of calcium, from which it appears that this salt, even in minute quantities, exerts a powerful antiseptic action; while, in his opinion, the small amount of iodine which they contain, by alternate oxidation and reduction, plays an important part in the economy of the ocean's waters. We should be on our guard against the too hasty acceptance of any theory of the *modus operandi* of medicines, but chemical analogies are greatly in favor of this hypothesis of the action of a considerable class of remedies. In such a way does chemistry become the handmaid alike to pharmacy and to therapeutics.

Second in importance only to anæsthetics is become the use of antiseptics in surgery, and the iodate just noticed may probably take a high rank among those which act by oxidation, in which class are included the permanganates and the hypochlorites. There is, however, another class, of which carbolic acid is the type, which, by their action on albuminous substances, have the power of destroying the vitality of organic germs, — the invisible but powerful agents by which nature hastens the decay of dead matter. The use of solutions of carbolic acid, as applied by Lister, seems to have introduced a new era in operative surgery.

The steps by which we have passed in pharmacy from the crude preparations of coal-tar to its essential principle, the pure carbolic acid, have involved much chemical research, but it has been reserved for recent chemistry to make another important advance in this direction. The taste, odor, and somewhat irritant effects of carbolic acid, even in its purified state, were, in certain cases, objections to

its use, but a consideration of its chemical relations, by a process of reasoning recalling that which conducted to the discovery of the virtues of chloral, has led to a substitute free from these objections. It had long been known that salicylic acid, formerly a rare organic product, is by heat decomposed into a mixture of carbonic and carbolic acids, and a method of producing it abundantly by the union of these two has been devised. It having occurred to a chemist that salicylic acid might partake of the antiseptic properties of carbolic acid, he has recently instituted experiments which fully confirm this anticipation, and show we have in this solid, inodorous, and comparatively tasteless body an antiseptic agent as efficient as carbolic acid, and applicable in very many cases where the former would be inadmissible, both in surgery and in medicine, and probably also in domestic economy for the conservation of perishable articles of food.

The relations, not only of putrefaction and decay but of many morbid conditions of the body, to the development of various minute organisms, both vegetable and animal, has of late greatly occupied the attention of physiologists, who have asserted the zymotic character of many diseases. Where such is really the case we have probably very much to hope from the internal and external use of antiseptics like those just mentioned, which, while without prejudicial action on the animal economy, have the power of destroying these minute organisms and their germs. A wide and fruitful field of investigation is here opened alike to the chemist, the pharmacist, and the physiologist.

The fungoid parasitic scourges of the vegetable kingdom have also been found to be subdued by chemical agents, as has been shown in the diseases of the vine in France, where pharmacy has already done great service ; for vegetable and animal life are so nearly akin, both in health and disease, that agriculture, too, has its pharmacology. Its work begins with the preparation of the seed for sowing, where lime, and more often sulphate of copper, is employed to destroy in the embryo plant the germs of disease, and where, as shown by recent experiments confirming those made long since, camphor exerts a remarkable influence favoring the germination of the seed itself, — an observation which invites further investigation in this direction. The use of various stimulating fertilizers for the growing plant may also be fairly said to be applications of pharmacy to the vegetable kingdom.

A subject trenching closely on the field just mentioned is that of ferments. While the conversion of sugar into alcohol and carbonic

acid, and various similar changes, are clearly connected with the growth and development of fungi, there are other chemical transformations, having with these many characters in common, in which no such relation is recognized. Such are the changes wrought by diastase upon starch, and by emulsine upon salicine, amygdaline, and many related bodies, akin to which are some of the most important phenomena connected with animal nutrition. The agencies by which various kinds of food are converted into soluble and assimilable forms are dependent upon azotized principles found in the salivary, gastric, and pancreatic secretions, the mode of whose action is not explained by referring it to what is vaguely called catalysis or contact-action.

But while our science is as yet impotent to explain their action, pharmaceutical skill has given us a means of utilizing the peculiar virtues of these principles, which have become precious aids to the human stomach in cases of impaired digestion. Pepsine for the solution of albuminoids, pancreatine to assist in the assimilation of fats, and more recently ptyaline, the active principle of the saliva, have all been added to our resources for the treatment of disease. We supplement the enfeebled forces of the human organism by agents drawn from the lower animals, which not only serve directly for the nourishment of our bodies, but by the agents which they, in common with ourselves, possess for the assimilation of food, are made subservient to the wants of our frames in disease.

But I have occupied you too long with these excursions into the field of pharmaceutical chemistry, in which my design has been to show how chemical science has paid back to pharmacy the debt which she owed for the fostering care which in past centuries gave her form and shape. I speak of chemistry and not of chemists, of pharmacy and not of pharmacists, — and with design ; for while I can distinguish the objects, I cannot discriminate between the workers. The pharmacist, it is true, works with a special aim, — the discovery of new principles and facts which may guide him in adapting remedies to the treatment of disease ; but to this end he finds it necessary to invent new modes of chemical analysis, to search out the proximate principles of plants and animals, and to avail himself of the whole arcana of secrets which the chemist in the past has gathered together.

No noble mind can thus pursue chemistry for an end without at last learning to follow it for its own sake. There are always to be found in the pursuit of knowledge two incentives, the highest of

which is the discovery of truth. It is a good and praiseworthy object to seek for the best means of extracting a metal from its vein-stone or an essence from the herb, that by the one we may give health to the sick and by the other may gain gold. These have their pleasure and their compensation ; but there is a higher pleasure which he alone knows who, with a pure, disinterested motive, unmindful whether his labors are to bring him health, wealth, or fame, toils patiently to discover the hidden laws in obedience to which nature elaborates in the cells of the plant that essence, or gathers from the rocks and the waters the metal which gives richness to the vein. He who studies with his spirit will discover, at last, that in searching after and finding the greater he has also attained the lesser end.

Every page of science is filled with illustrations of this truth ; the foundations of our greatest discoveries in modern physics and chemistry were laid by those who little recked of the immense practical results which were hidden in their findings-out. It was with a reverent spirit and with the invocation of the Holy Name, that the alchemists were instructed to approach their tasks, and a religious regard for the higher powers was a controlling influence with these early workers in science as well as in art. In all such cases may we not reverently say, that to those who seek the highest good and the highest knowledge all other things shall be superadded ? Thus it ever happens, in accordance with the Divine order, that the worker must lose himself and his lower aims in his work, and in so doing find his highest reward, for the profit of his labor shall be, in the language of one of old, to the glory of the Creator and to the relief of man's estate.

But let us return to our legitimate theme. You have seen how, in considering the relations of chemistry to pharmacy, I have found myself at each step encroaching upon the domains of the physician and the physiologist. If the pharmacist must be a chemist, it is not the less necessary that the physician should also be learned in the science. We have observed throughout our inquiry this evening that a profound knowledge of chemistry lies at the very basis of therapeutics, and that scarce a step can be made in the treatment of disease without calling to our aid some of the principles which the chemist is finding out and the pharmacist is utilizing. The physiological chemist and the pharmaceutical chemist have become the fellow-laborers with the physician and the surgeon, different parts of that great army of laborers engaged in the task of combating disease and death, subduing suffering, and prolonging life. More and more, as

the limits of human knowledge expand, it becomes beyond the power of one mind to grasp the whole, and a greater subdivision of labor is necessary; but more and more also it grows apparent that in these closely related fields of study an intelligent co-operation is necessary, and that, while the physician must be a chemist and skilled in the theory of pharmacy, the pharmacist should be familiar alike with therapeutics and with chemistry and physiology.

You, gentlemen of the College of Pharmacy, have felt this conviction, and have been inspired by it in your self-denying and philanthropic endeavors to raise the standard of pharmaceutical education among us, and you can point with just pride to the goodly assembly before you, and the increasing number of your students, as evidences that your work is appreciated alike by the medical profession and by the public The immense advances made in your art, and the constant contributions brought to it by chemistry, demand each year a higher education for the profession of pharmacy, and the day cannot be far distant when throughout our land the need of a regular training and a thorough scientific education will be felt as indispensable for the pharmacist as it is for the physician and the surgeon. To this result wise legislation, which has already intervened in other States, will greatly contribute; and let us hope that this Commonwealth, whose boast it has been in the past to be a leader in all educational enterprises, will not be left too far behind in a measure of so much importance to the welfare of its citizens.

VALEDICTORY ADDRESS TO THE CLASS OF 1875.

By Prof. W. P. Bolles, M.D.

Gentlemen Graduates, — It rests upon me to-night to complete the ceremonies with which it is the custom of this College to honor its graduating class, by commending you to the confidence of the public, for whose service you have just fitted yourselves, and before whom you now stand, and then bidding you, as students, on behalf of the College, a formal farewell. It is surely a time for congratulations. You are happy and proud of the success you have obtained, and well may be, for you have earned it by hard and steady work. You have done well. But lest too much praise beget indolence, and that self-conceit which is the ruin of all further progress, I will rather spend this last hour in guiding you through some of the difficulties before you than in any such flattery as might make you forget them.

The abundant illustrations and earnest eloquence of our orator leave me in some respects only the privilege of seconding his well-expressed sentiments, which I heartily do, as well as the compliments and advice of your president. But the lecturer said that he spoke "of chemistry and not of chemists, of pharmacy and not of pharmacists"; and here our lines differ; for mine is the far humbler task to speak of pharmacists only, not of pharmacy or chemistry; and if I can, by telling you a few wholesome though unpalatable truths, enable you, on your part, to elevate and purify your profession in the future, as your best predecessors have done in the past, my task will be done.

The ordeal through which you have passed, your long service, the study, the lectures, and the trying examinations, — all indicate our present estimate of the importance of your calling and of the necessity for a thorough preparation to enable you to follow it

properly. Graduation does not by any means imply that you know all which it is desirable for pharmacists to know. No one at his graduation does, — no one at your ages can. He who has finished his education, be assured, can never have had much to complete. It simply means that you have fairly risen above a line beneath which we should decline to say that any one ought to be considered competent to practise as an apothecary. You can stand alone; next you must walk. You have gained "glory enough for to-day," but this is not enough for to-morrow, for life is never still.

I was told when a boy that the sun rose in the east, and passing over the earth, set again in the west, and believed it. Shortly after I was taught that this was not so, but the earth's rotation gave us this appearance, the sun meanwhile standing still; and again after this that the sun was not still, but moving away, round a far distant centre of its own. So I asked my father at last why he had taught me this series of untruths, and well remember his careful explanation that these partial statements were all that I could have comprehended at the times when he made them, and though untrue for me now, were truer for me then than the whole truth would have been. Since then, though still young, I have lived long enough to have seen changes in the world's knowledge almost as great as those were in the boy's, —to have studied Physics before the discovery which has overturned its whole philosophy of the permanence and close relationship of forces; to have learned Chemistry by the old notation, and Botany under the Linnæan system. It really seems sometimes as if unlearning took as much of my time as learning. Everything is changing; common history even, fixed as its truths must be in the past, is daily changing to us, from the accumulation of new facts or the different collation of old ones, so that those writers who were famous in our father's days are now thought unfit for us to rely upon. Social and moral beliefs are equally subject to this law; things which would have horrified the good people of a century ago meet the approval of the same class now, who in their turn would equally shrink from many others thought proper by the first. Thus the mind of the world grows like that of the boy, and knowledge which was true for it once becomes no longer so. It is a part of the same law shown by successive forms of plants and animals in the earth's history, appearing likewise in the development of minds in human history; and if you do not actively share in this development by adding something to your knowledge from day to day, you will find your-

selves soon buried by it, as dead plants and animals lie buried by the *débris* of the living. The College, too, must share in this progress as well as you ; must quickly grasp every new advance within its domain, and improve its course as fast as the material which it has to handle will permit.

Something has been accomplished towards giving young men a respectable education in pharmacy ; but more, much more remains to be done. The necessity of a liberal education, to begin with, shortly, let us hope, will compel it to take the next important step, following the example of our medical school and require at least a *little general* knowledge of every man who seeks the honor of its endorsement, and then ask every pharmacist in the city, before he takes an apprentice to instruct in his profession, to make himself sure that he will come up to this standard And may the day be not too far distant, gentlemen, when an ample laboratory, museum, and all the conveniences that a new building would offer shall be added to it, enabling it to promise a course of study that shall profitably use the entire time of such of its students as can give it. For all these improvements we need the countenance and support of you and the people, and we ask it.

The position of the apothecary in the community is in some respects a peculiar and trying one. The facts that he deals in goods of which his patrons are not judges ; that these are ordered by a physician who may never see them, to be taken by a patient who does not know them ; that the best qualities of them often cost from four to eight times as much as the worst, while none but an expert can tell the difference between them, — expose him peculiarly to temptations which often ruin the characters of other merchants. But to their honor be it said, I know of no class of people with whom so great a risk can be so safely trusted as with the respectable apothecary. The only apology which I have for mentioning it at all is lest some questionable neighbor, who uses his mortar only to hide as with a cloak some less respectable business, should tempt you to try to compete with him in price. You cannot do it. A cheaper article substituted in a recipe for a dear one, or half its most costly ingredient instead of the whole, are deceptions that in some lines of business, perhaps, might be comparatively harmless, but here *no one can tell what is harmless*, and he who tampers with his recipes is trifling with human life. You can only wait in patience for your patrons to learn that no one whom they would not trust in other respects is fit to be trusted with their prescriptions,

and that the necessities of sickness are the worst subjects for economy.

You are not physicians: do not allow yourselves to be called so. Examining and prescribing for the sick is not your business, neither is it for you to mix some secret "cure all" to urge upon your customers, or pile breast-high in your windows and recommend for all sorts of diseases. What essential difference is there between the druggist who does this and the common quack who may not keep a drug store? All people do not need the same medicine; every one is not a candidate for Iodide of Potassium. There are many family medicines in common use which are conveniences both for physicians and people, and I have no desire to curtail the list except to remove the dangerous and useless ones. On the contrary, I wish they were better known, and that thirty or more simple and safe officinal preparations were so familiar to all that they could be properly used in those cases where no physician is needed; for then acknowledged medicines might take the place in people's stomachs, when wanted, of the many much-vaunted frauds which now load some windows, usually in inverse ratio to the standing of the apothecary behind them; and the physician, if called upon at last, will know exactly what has been done. But you are not to *prescribe* even these: there is a great difference between *selling* a bottle of Tincture of Cinchona to a person who asks you for a bitter, and *prescribing* the same to another who asks you what he needs; for while you know what is a good bitter, you may not know what a sick man needs. Of course, you will always do what common neighbors should for each other; any one would put a rag or plaster on a slightly cut finger, give a little ammonia to a fainting woman, or any such simple thing. But the test is this: when a physician is needed or there is any question about his being needed, you are not the men for the place, any more than I am the man to write your leases or buy your goods.

The aim and limit of the pharmacist's true office is to properly prepare and dispense medicines for the sick, and sell the usual sick-room conveniences; though there are many other things done by all, with greater or less propriety, which will be done by you, — the necessity of living will drive you to it; but this is the key-note of your profession, to which all others, so far as practicable, should conform; for which, and for which alone, the college course has trained you. Keep it always in your minds, and let the character of your store declare it.

See for a moment in this light what an incongruous mixture the modern "Pharmacy" is, and judge how well your highest needs are satisfied by it. It has the corner store of the last built marble block and fronts upon the square. Its front and side are continuous walls of plate-glass; the windows are filled with glass; the signs are etched glass; it seems as if the solid masonry above rested on nothing but glass. There is an inlaid mortar in the sidewalk near the door, and an enormous one hangs over it, of a shape impossible for use, holding a pestle that must be broken if it touches the bottom. It illuminates the whole square at night with its many colored lights. As you enter, a hissing like that of an overcharged boiler comes from a magnificent miniature cathedral of variegated marble standing before you, almost hiding the view of the room. A female figure beneath a bell is being mercilessly washed, while tumblers are waltzing in a basin near by. Passing this, the room stretches magnificently into the distance. The marble counters on either side, the crystal chandeliers above, can almost be seen reflected in the polished marble floor. Mortars and flowers are mingled in the frescos of the ceiling. An inlaid walnut case also, more or less Gothic, covers the partition side, and is filled from end to end with gilded bottles standing like soldiers at a dress parade. A little screen at the farther end is marked "Dispensing Counter"; a door near by, labelled in large letters "Laboratory," opens into — a closet. It is spring, and the long lines of "chest protectors" have disappeared from the windows to give place, in the first one, to a mammoth effigy of the bottle of an "insect destroyer," surrounded by dozens of marketable bottles of the same banked up against it. Sheets of fly-paper here and there hold struggling victims and advertise themselves. "Temperance Bitters" and "Bilious Cordials" form a sort of pyramid in the next. In the third an officinal display is made with jars of Ginger, Cardamom, and Rhubarb; and innocently mingled with these, a few bottles of well-known liquors suggest that these are medicines as well as any, for the urbane proprietor has paid "all the necessary licenses," without grumbling. The fourth window is devoted to perfumery and soaps, and holds a glass sign, stating "that orders for cleaning kid gloves are received here." The window counter contains cigars and the choicer brands of tobacco, with pouches and various smoker's conveniences. Sometimes a meerschaum pipe or cigar-holder happens to be in the case. A fat "smoking Dutchman" puffs out a little jet of gas near by. At the farther end are pocket

liquor-flasks. On the other counter is an assortment of toilet articles, all of good quality, and one end of it is devoted to the usual sundries of the sick room. There is an anxious father waiting here with a recipe for his dear one at home, while some sociable ladies finish their soda, and a fastidious young gentleman's taste in cigars is satisfied before his pressing needs can be attended to.

Next let me portray what a simple "pharmacy" might be. "An idle, impracticable doctor's picture," you will say. Let it be so; but as far as it is desirable it will come at some time, though that time be beyond our days, and there can certainly be no harm in looking at it now. It also fronts upon the street and is easily found. A quiet door, over which perhaps hangs the mortar, bears a handsome plate engraved with the name and title of the owner, and stands between the two windows containing the emblems of the business. This opens into a pleasant, easy waiting room, carpeted, and containing chairs for its guests. A few pictures may hang upon the walls, but cherubs are not used here to advertise physics. There is a case and counter in the room in which various apparatus are kept to be shown when wanted, but syringes and nasal douches are not thrust into the face of every visitor. No medicines are in sight. Opening from this room are the laboratory and storeroom, where the stock is manufactured, kept, and dispensed; here are all the medicines, carefully arranged for the greatest possible convenience, and here the recipe is put up while the customer waits outside. No one is admitted but the proprietor and his assistants; everything is convenient and good, but nothing is wasted for show. The receipts are not large, but neither are the expenses.

You cannot keep such a store as this until the people have been prepared to sustain it, for they are very prone to believe that the largest bottles and most costly shelves must contain the freshest cures; but such extravagance and show as the first are inconvenient and in bad taste; the fixtures have cost nearly as much as the building containing them, are far less convenient than those of many a smaller store, and, however it may be concealed, must be paid for by those who buy their goods there. I shall be glad to see a public distaste created for this class of fittings, until the temptation to make them shall no longer exist. You can prove that it is not necessary, by sending out from your little stores equally good or better, and perhaps cheaper goods. Resolve that your stores shall not be great pagodas built over soda fountains as idols, making you ransack every kind of merchandise, from hardware to gro

ceries, to make them pay expenses. It discredits the scientific part of your calling to do so. If you are chemists, your chief room is the preparing-room and not the sale-room: fit this with all the conveniences which you can afford; then let the store be neat and nice, but not too costly. Keep soda and combs if you must, and if you do keep them let them be good, but let the fountain be small and plain. Feel yourselves, and let the whole atmosphere of your store say, that it is a condescension in you to do so, and not your chief pride. Prove to all that you are not simple tradespeople, that the charges you make are not merchant's profits on goods, but compensation asked for skilled work in preparing them, and see to it, too, that this work is worth the price. Put your titles upon your labels, and live up to their promises, that it may be known that "G. P." means something, as it is now known that "M. D." or "Member of the Massachusetts Medical Society" means something.

You must not, however, expect an easy path before you if you undertake any such course. It is hard to live if out of the fashion, and harder still for young men like you to change the fashion; but you can do something, and if your hearts lean in this direction, an opportunity for a little change here or a little improvement there, and the silent force of your characters will bring about in twenty or thirty years a degree of change which would astonish you if you could see it all at once.

I have said this to you in public with perhaps more earnestness than good taste, because it is necessary for all to know what is desirable to be done and how it may be effected, in order that you may receive from the public that without which you can do nothing, — their cordial approval and support, which the College sincerely hopes may be accorded to each one of you in its fullest and heartiest sense.

And now, gentlemen, for the College, I bid you farewell, hoping that the recollection of your course here, which has been a pleasant one to your teachers, may ever remain a delightful reminiscence to you as long as you live.

May 20, 1875.